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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to storage equipment and a computer network system equipped with the list of the host computer with which access to the volume concerned is allowed the volume which starts the storage equipment shared from two or more host computers, especially contains own [ at least / a part of ] by the unit.

[0002]

[Description of the Prior Art] In recent years, expansion of the amount of the information which a computer treats is being enhanced, and the sex for Takayoshi and the high throughput are demanded also of storage equipment. The computer network with which each host computer can share storage equipment between connecting two or more host computers and at least one storage equipment to what attracts attention as the technique of meeting such a demand by at least one network is known. Such computer network is called a Storage Area Network (Storage Area Network:SAN). In current SAN, a protocol compatible with SCSI (Small Computer System Interface) is used in many cases.

[0003] The configuration of the computer network containing a host computer and storage equipment takes the form where direct continuation of each storage equipment is carried out to a host computer (it is hereafter called a host for short), in the computer network before SAN, for example, LAN, (local area network). On the other hand in SAN, the network of a monologue is made, at least one storage equipment, for example, the storage equipment group, other than a network which connects a host group, (the thing of the network of this latter is called SAN), and the form which each host connects to SAN is taken.

[0004] To the storage equipment which constitutes SAN, it can access from every host linked to SAN. While flexible employment of storage equipment is attained, problems, such as security, will also be produced from this.

[0005] The method of restricting the host who is the logical unit of storage as a method of coping with this problem and who can access to that volume for every volume is learned. Although storage equipment usually performs processing of a passage to the access request from the host who this approach prepared the list (access-restriction list) of an accessible host for every volume, and appears in this list, the demand from the host who does not appear refuses. This approach is called access restriction. In addition, in volume, the case where two or more volumes exist in one storage equipment, and the storage equipment of plurality, conversely may constitute one volume.

[0006] Now, when a certain storage equipment on the network concerned detects own failure etc. in the computer network containing a host computer and storage equipment, it is desirable to notify a host of the condition.

[0007] In the computer network before SAN, since the host who can carry out direct access to storage equipment is restricted only to the host by whom the equipment was connected, he should just notify the host of failure etc. from storage equipment.

[0008] However, in SAN, the problem that it is not known which host should generally be notified of failure etc. from storage equipment to storage equipment since two or more sets of unspecified hosts are accessible arises. Then, it is possible to notify from storage equipment to all the hosts on SAN. However, since there are some hosts who do not access that storage equipment at all, the situation where the host who

does not assume receiving a notice from that the futility of a resource performs this notice to all hosts and the storage equipment which is not accessed breaks down may be caused.

[0009]

[Problem(s) to be Solved by the Invention] It is mentioned that it can access from two or more sets of the unspecified hosts who generally connected with SAN to the storage equipment on SAN as one of the descriptions of SAN as described above. However, in the conventional technique, the problem that it was not known which host should be notified existed to perform a certain notice of the notice of failure etc. on account of the description of this SAN to the host who accesses self from storage equipment. This problem exists to ask the condition of the host concerned etc. from storage equipment to the host who accesses self. That is, the method of specifying the host (host computer) to whom storage equipment accesses self in the conventional technique did not exist. This invention is what was made in consideration of the above-mentioned situation. The purpose By using a list of an accessible host computer for every volume It is in specifying all the host computers that can access self and offering the storage equipment and the computer network system which can perform the notice of a condition, or a condition inquiry only between the host computer.

[0010]

[Means for Solving the Problem] This invention is storage equipment in the calculating-machine network system to which two or more host computers and at least one storage equipment were connected by at least one network. For every volume which is at least one logical storage unit which exists in at least one storage equipment containing said storage equipment itself An access-restriction list storage means to memorize the access-restriction list into which the host computer with which access to the volume concerned is permitted among said two or more host computers was registered, When access to the above-mentioned volume from the host computer of either of two or more above-mentioned host computers is required, The access-restriction control means which determines the propriety of access to the volume concerned by the host computer which required the above-mentioned access based on the above-mentioned access-restriction list corresponding to the volume concerned, An inquiry of the condition of a class of having been beforehand set for every volume of the notice in the condition of a class of having been beforehand set for every above-mentioned volume of storage equipment own [ above-mentioned ], or the above-mentioned host computer It is characterized by having the communications control means performed only to the host computer registered into the above-mentioned access-restriction list corresponding to the volume concerned.

[0011] In the storage equipment of such a configuration, in order [ which should be notified using the access-restriction list into which the host computer with which access to own volume is permitted is registered ] to specify a \*\*\*\*\* host computer again and to perform the notice of a condition, or a condition inquiry only to the host computer, it can prevent that the unnecessary notice of a condition to the host computer with which access is not permitted, or a condition inquiry occurs.

[0012] Here, if the condition of being notified to a host computer is considered as the failure for every volume, when failure of the volume concerned is detected, failure of the volume concerned can be notified only to the host computer with which access to the volume concerned is permitted, and the futility of a resource like [ in the case of notifying failure to all host computers ] can be prevented.

[0013] Similarly, if the condition of being notified to a host computer is made into the condition of the load for every volume, for example, the condition of having exceeded normally the upper limit of a load which can operate When the heavy load condition in which the load of the volume concerned exceeded the above-mentioned upper limit is detected The heavy load condition of the volume concerned can be notified only to the host computer with which access to the volume concerned is permitted, and the futility of a resource like [ in the case of notifying a heavy load condition to all host computers ] can be prevented. Or it reduces the access frequency to the volume corresponding to a host computer here according to the heavy load condition detection from storage equipment, the mirror of the volume concerned is secured, and if the function to distribute access to the volume concerned is given, it will become possible to cancel the heavy load condition of the volume concerned.

[0014] Furthermore, it is going to access the condition of asking a host computer at corresponding volume. If the data to a cache are predicted based on the access information which considered as the access

information (access pattern) which shows the contents of reservation of the access, and was notified from the host computer of a reference according to the inquiry Even when the access request for every volume from a host computer to storage equipment must be divided and sent out to multiple times by constraint of the communications protocol to apply, it can become a cache hit and access efficiency can be raised.

[0015]

[Embodiment of the Invention] Hereafter, with reference to a drawing, it explains per gestalt of operation of this invention.

[0016] Drawing 1 shows the configuration of the computer network system concerning 1 operation gestalt of this invention. The system of drawing 1 is the calculating-machine network system called SAN, i.e., the calculating-machine network system constituted by connecting two or more host computers and at least one storage equipment by at least one network, for example, consists of a group of the storage equipments S0-Sn, Hosts (host computer) A0-An and the group of B0-Bn, and a network N for data communication. This network N is constituted for example, using a fiber channel (Fibre Channel). The group of the storage equipments S0-Sn is connected in Network N. Hosts A0-An and the group of B0-Bn are also connected to this network N.

[0017] In the system of drawing 1, the communication link between each storage equipment Si (i=0-n) and Hosts Aj (j=0-n) or Bk (k=0-n) shall be performed by the protocol also with the communication link of data same on the network N where the communication link of other control etc. is also the same. A protocol compatible with SCSI etc. is applicable to this protocol. In addition to the usual storage equipment driver for accessing storage equipment Si, on Host Aj and Bk, the target driver for receiving the communication link to Hosts Aj and Bk from storage equipment Si operates. In addition, preparing independently, the network for control etc., for example, LAN, other than the network N for data communication, and mounting using two or more protocols by the application are also still more possible.

[0018] Storage equipment S0 has the volumes L0-Ln as a logical storage unit inside. Storage equipment S0 performs access restriction for every volumes L0-Ln of such. One volumes L0-Ln may exist ranging over two or more storage equipments, when it exists not only when it exists in one storage equipment S0 like this example, but for every one storage equipment.

[0019] Storage equipment S0 has the storage region where the access-restriction list (access-restriction table) T0 which is a list of the host who allows access to the volume L0 concerned is stored about volume L0 in order to manage this access restriction. Storage equipment S0 has the access-restriction lists T1-Tn about volumes L1-Ln other than L0 similarly. Here, only A0-An are recorded on the access-restriction list T0 so that the corresponding volume L0 may be accessed by only Hosts A0-An. Each lists T0-Tn can be set up, for example by actuation of a system administrator from Hosts A0-An, or B0-Bn. In addition, although the number of Hosts A0-An, the number of Hosts B0-Bn, the number of the storage equipments S0-Sn, and the number of Volumes L0-Ln are considering as the same thing for convenience in the system of drawing 1, of course, it is not what is restricted to this.

[0020] Storage equipment S0 has the cache (cache memory) CA 0 with which some counterparts of the control unit C0 which controls a communication link by delivering and receiving the above-mentioned protocol and carrying out interpretation activation again, and the data stored in the storage equipment S0 concerned in order to make possible high-speed read-out from the storage equipment S0 concerned are memorized. It has the same configuration as S0 also about storage equipments other than S0 among the storage equipments S0-Sn.

[0021] A control unit C0 consists of the access-restriction control section C01, the fault detection section C02, the notice section C03 of failure, the load Monitoring Department C04, the notice section C05 of a heavy load, the access information inquiry section C06, and the prefetch section C07, as shown in drawing 2.

[0022] The access-restriction control section C01 is determining the propriety of access to the volume Lp (p=0-n) demanded by Hosts Aj (j=0-n) or Bk (k=0-n) according to the access-restriction lists T0-Tn, and controls a limit of access to the volume Lp concerned.

[0023] The fault detection section C02 detects failure of each volumes L0-Ln, and the failure related to the storage equipment S0 whole. The notice section C03 of failure notifies a host with the accessible volume relevant to the locating fault of failure according to the fault detection result by the fault detection section

C02.

[0024] The load Monitoring Department C04 supervises the load of storage equipment S0 for every volumes L0-Ln, and the load is the reference level set up beforehand, and it detects the heavy load normally exceeding the reference level (upper limit of a load) which can operate. According to heavy load detection of the load Monitoring Department C04, the volume which became a heavy load about that notifies an accessible host of the notice section C05 of a heavy load.

[0025] The access information inquiry section C06 asks the information (access information) which shows the contents of access reservation to the volume concerned to the volume concerned to an accessible host for every volumes L0-Ln. The prefetch section C07 prefetches corresponding data into a cache CA 0 using the access information acquired by the inquiry by the access information inquiry section C06.

[0026] Next, sequential explanation of the actuation of this operation gestalt is given about each at the time of (4) access-information inquiry at the time of (3) heavy-load detection at the time of (2) fault detection at the time of the access request from (1) host.

[0027] (1) Explain the processing at the time of the access request from a host with reference to the flow chart of drawing 3 R>3 first at the time of the access request from a host.

[0028] Now, access to volume L0 should be required from storage equipment S0 from Hosts A0-An and the host of the either B0 or-the Bn(s). The access-restriction control section C01 in the control unit C0 prepared in storage equipment S0 judges whether the host of access request origin is registered during the list T0 with reference to the access-restriction list T0 corresponding to the demanded volume L0 (step 301,302). If registered, the access-restriction control section C01 will return an access permission to a requiring agency host using the above-mentioned protocol (protocol compatible with SCSI) (step 303). On the other hand, if not registered, the access-restriction control section C01 will return access disapproval to a requiring agency (step 304). Here, Hosts A0-An are registered into the access-restriction list T0.

Therefore, when the access request origin to volume L0 is either of the hosts A0-An, an access permission is returned, and access disapproval is returned when it is either of the hosts B0-Bn (i.e., when it is except a host A0 - An).

[0029] (2) Explain the processing at the time of fault detection, next fault detection with reference to the flow chart of drawing 4.

[0030] First, the fault detection section C02 in the control unit C0 prepared in storage equipment S0 detects failure of the storage equipment S0 whole, and the failure for every volumes L0-Ln. When a certain failure is detected by the control unit C0, that is notified to the notice section C03 of failure with the information on the detected locating fault. In response, the notice section C03 of failure judges whether failure of the storage equipment S0 whole was detected (step 401). If the whole failure is detected, the notice section C03 of failure will question the host registered into the access-restriction lists T0-Tn corresponding to all the volumes L0-Ln concerned as that to which Volumes L0-Ln broke down altogether (step 402). And the notice section C03 of failure notifies failure using the above-mentioned protocol only to the host registered into Lists T0-Tn (step 403).

[0031] On the other hand, if not the whole failure but one volume failure of the volumes L0-Ln is detected (step 401), the notice section C03 of failure will question the host registered into the access-restriction list corresponding to the volume by which failure was detected (step 404). And the notice section C03 of failure notifies failure using the above-mentioned protocol only to the host registered into the access-restriction list corresponding to the volume by which failure was detected (step 403). Therefore, if it is the case where failure of volume L0 is detected, failure of volume L0 will be notified only to the hosts A0-An registered into the access-restriction list T0. Here, it is because the hosts B0-Bn concerned do not need to access volume L0, therefore that failure of volume L0 is not notified to Hosts B0-Bn does not need to receive the notice of failure of volume L0, and can prevent that an unnecessary load is generated in Network N and Hosts B0-Bn by this.

[0032] Thus, in this operation gestalt, since failure is notified only to the host who needs to receive the notice of failure when failure of the storage equipment S0 whole or one failure of the volumes L0-Ln in storage equipment S0 is detected, the useless load in a host unrelated to Network N and a locating fault can be reduced.

[0033] (3) Explain the processing at the time of detecting the time of heavy load detection, next heavy load

detection processing and a heavy load with reference to the flow chart of drawing 5.

[0034] First, the load Monitoring Department C04 in the control unit C0 prepared in storage equipment S0 is supervising the load of the volumes L0-Ln concerned for every volumes L0-Ln. Here, the load of each volumes L0-Ln is called for as an amount of transfers per fixed time amount in the data transfer generated when the volumes L0-Ln concerned are accessed by the host to whom access to the volumes L0-Ln concerned is permitted, respectively.

[0035] The load Monitoring Department C04 asks for the load of each volumes L0-Ln concerned at intervals of between (period) top Norikazu scheduled time by the load monitor for every volumes L0-Ln (step 501). The load Monitoring Department C04 compares the load of each volumes L0-Ln for which it asked with the upper limit (threshold) of the load beforehand set up for every volumes L0-Ln (step 502). The upper limit of the load for every volumes L0-Ln of these shows the upper limit of a load which can perform normally access to the volumes L0-Ln concerned, and is beforehand set up by actuation of a system administrator according to a storage management program etc. from Hosts A0-An and the host of the either B0 or-the Bn(s).

[0036] The load Monitoring Department C04 detects the heavy load to which the volume Lp (either p0-n) in which the load is over the load upper limit exists in Volumes L0-Ln by comparison at the above-mentioned step 502 (step 503). Then, the purport by which the heavy load was detected from the load Monitoring Department C04 to the notice section C05 of a heavy load is notified with the information on Volume Lp that the heavy load was detected (step 504).

[0037] In response, the notice section C05 of a heavy load questions the host registered into the list Tp concerned with reference to the access-restriction list Tp corresponding to the volume Lp by which the heavy load was detected (step 505). And the notice section C05 of a heavy load notifies the purport from which Volume Lp serves as a heavy load using the above-mentioned protocol only to the host registered into List Tp (step 506).

[0038] Here, if the volume Lp by which the heavy load was detected shall be L0, therefore List Tp shall be T0, it will be notified that the heavy load of the volume L0 concerned, i.e., a load, is high unusually to the available hosts A0-An exceeding a upper limit about volume L0. By notifying that volume L0 is a heavy load from the notice section C05 of a heavy load in the control unit C0 prepared in storage equipment S0, Hosts A0-An operate so that the load of the volume L0 concerned may be reduced.

[0039] With this operation gestalt, as an approach of reducing the load of volume L0, the approach to volume L0 of reducing the frequency of access, Or are among Hosts A0-An, for example, the host set beforehand controls storage equipment S0, and secures the mirror (mirror volume) of volume L0 on the storage equipment S0 concerned. The method of making access to the original volume L0 and access to the mirror (mirror volume) distribute access to volume L0 etc. is applied. In addition, by the approach of using mirror volume, to also allow write-in access, it is necessary to attain identification of volume L0 and its mirror volume. For that purpose, what is necessary is just to reflect in both volume L0 and its mirror volume suitably the data updated on the cache CA 0, for example, using a cache CA 0 common to volume L0 and its mirror volume (write back).

[0040] (4) Explain the processing at the time of an access information inquiry, next an access information inquiry with reference to the flow chart of drawing 6.

[0041] First, the access information inquiry section C06 in the control unit C0 prepared in storage equipment S0 is referred to the period which was able to define beforehand the access-restriction lists T0-Tn currently prepared for every volumes L0-Ln, and the host registered into the lists T0-Tn concerned is questioned (step 601,604). Next, the access information inquiry section C06 asks the information about the contents of reservation of access to the volumes L0-Ln which it is going to perform from now on, i.e., the access pattern information which shows an access place and the amount of accesses (size), to each host registered into Lists T0-Tn, and notifies that to the prefetch section C07 (step 602,603). The period of this inquiry is beforehand set up by actuation of a system administrator according to a storage management program etc. from Hosts A0-An and the host of the either B0 or-the Bn(s).

[0042] Each host who received the inquiry from the access information inquiry section C06 returns the access pattern information about the contents of access reservation to the volume which an inquiry shows to storage equipment S0. The access pattern information about access to each volume returned to this

storage equipment S0 is received in the prefetch section C07 (step 605). The prefetch section C07 prefetches the data which the access pattern information concerned shows into a cache CA 0 based on the access pattern information about access to each volume received from the access information inquiry section C06 (step 606). When some or all of data that access pattern information shows already exists in a cache CA 0 here, the pre-planned system of the corresponding data is unnecessary.

[0043] With this operation gestalt, the SCSI compatible protocol is applied to the communication link through the network N of Hosts A0-An, and the B0-Bn and the storage equipments S0-Sn. In a SCSI compatible protocol, an upper limit is in the amount of data (size) which can be specified by 1 time of the access request to storage equipment from a host. For this reason, even if the access place and the amount of data which it is going to access from the host to storage equipment S0 were found conventionally, when that amount of data exceeded the value of the above-mentioned upper limit, the access request was divided into multiple times and it sent out, and when there was nothing, it did not become. In this case, with storage equipment S0, in order to perform access processing demanded only from the access request from a host, at every demand, the cache mistake hit occurred and there was a possibility that access efficiency might fall.

[0044] However, with this operation gestalt, the data specified by the access request divided and sent out to multiple times from the host concerned from now on are prefetched into the cache CA 0 based on the access pattern information acquired by the inquiry to the host by the access information inquiry section C06. Thereby, at every access request from a host, it can prevent that a cache mistake hit occurs and access efficiency can be improved.

[0045] Although access information inquiry section C06 self in storage equipment (S0) explained with the operation gestalt described above as what asks access pattern information periodically, it does not restrict to this. For example, the access information inquiry section C06 concerned may be made to ask access pattern information by starting the access information inquiry section C06 with the instruction (instruction from the outside) from Hosts A0-An, the host of the either B0 or the Bn(s), etc. only at the time of the starting.

[0046] in addition, this invention is not limited to the above-mentioned operation gestalt, and in the range which does not deviate from the summary, many things are boiled and it can be deformed at an execution phase Furthermore, invention of various phases is included in the above-mentioned operation gestalt, and various invention may be extracted by the proper combination in two or more requirements for a configuration indicated. For example, even if some requirements for a configuration are deleted from all the requirements for a configuration shown in an operation gestalt, the technical problem stated in the column of Object of the Invention is solvable, and when the effectiveness stated in the column of an effect of the invention is acquired, the configuration from which this requirement for a configuration was deleted may be extracted as invention.

[0047]

[Effect of the Invention] As explained in full detail above, in order [ which should be notified using the access-restriction list into which the host computer with which access to own volume is permitted is registered ] to specify a \*\*\*\*\* host computer again and to perform the notice of a condition, or a condition inquiry only to the host computer, according to this invention, it can prevent that the unnecessary notice of a condition to the host computer with which access is not permitted, or a condition inquiry occurs.

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[Translation done.]